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ONTARIO DEPARTMENT OF EDUCATION

CURRICULUM S-27D

# ELEMENTS OF MECHANICAL TECHNOLOGY

GRADES 11 AND 12

1968

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# FOREWORD

An integrated technical course is one in which two or more disciplines that have common or complementary content are combined into one technology. This course outline in Elements of Mechanical Technology represents an integration of subject content in the mechanical field. The outline consists of three divisions: Core, Drafting and Design, and Machine Theory and Practice. It is intended for use in Grades 11 and 12.

At the secondary school level, we are concerned with fundamentals rather than the treatment in depth which characterizes the tertiary levels of education. An integrated approach is desirable because students understand basic principles best if they are able to relate them to several subjects. The relation of various technical subjects to Mathematics, Science, English, and History should be stressed repeatedly. In this way the technical subjects become effective educational vehicles as well as a means of learning skills.

Since the course is a two-year entity the teachers must decide the extent to which any unit will be studied in either Grade 11 or Grade 12. Although the arrangement of the outline is logical, it is not chronological: it is an analysis of subject content, not a synthesis. No attempt has been made to arrange these topics in a teaching sequence nor has any attempt been made to integrate the topics of the three divisions: these tasks are reserved for the professional teacher. The need for frequent consultation among the participating teachers is imperative. If possible, one or two periods per week should be set aside so that course construction, lesson planning, and evaluation can be pursued as a team effort.

The course outline was prepared on the understanding that a total of six hundred hours was available for implementation: of this time allotment, about twenty per cent should be devoted to Division 1, and forty per cent to Divisions 2 and 3. Teachers may alter these ratios somewhat, and may omit optional topics (marked "O") in favour of other material.

Approximately sixty per cent of the available time should be devoted to student activity that reinforces theoretical aspects. The teacher may, however, increase this ratio by developing individualized, imaginative methods. The inductive, directed-discovery approach should be implemented as frequently as possible.

Students should feel that they are taking one technical subject. This may be accomplished by innumerable arrangements and varieties of presentation. To illustrate the manner in which a given topic relates to sections in all divisions, one might consider gearing. Without any selection as to sequence or to depth of treatment, gearing can be related to the following:

| | |
|---|---|
| 11.1 | Metals |
| 11.3 | Material treatments |
| 12.2 | Material removal |
| 12.4 | Casting and moulding |
| 12.7 | Inspection |
| 13.3 | Drive mechanisms |
| 21.2 | Advanced projection systems |
| 21.4 | Industrial practices |
| 23.1 | Design considerations |
| 23.2 | Manufacturing considerations |
| 23.3 | Quality assurance |
| 31.2 | Milling machine operations |
| 31.7 | Shaper, planer and slotter operations |
| 33.1 | Measurement and gauging |
| 33.2 | Testing |

This list illustrates the fact that the course outline offers an organization of content, but does not inhibit teachers from developing a coherent sequence related to the particular requirements of their classes and the facilities at hand.

## SAFETY

The responsibility for providing technical areas that are designed and equipped from a safety point of view rests with the board of education. The maintenance of safe working and teaching conditions is the responsibility of the teacher and the technical director.

The teacher of Elements of Mechanical Technology has an excellent opportunity to condition his students so that they become "safety conscious" about all aspects of their school programs. If this goal is achieved, the students will tend to maintain this attitude of mind in all environments.

Upon request, professional accident-prevention associations will provide speakers, films, literature, and periodic inspections. A staff advisor and three or more students might form a committee to organize activities that would make the student body more aware of accident prevention. A special "safety week" is one possibility.

# AIMS AND OBJECTIVES

The aims of technical education are identical with those of education as a whole: developing each student's personality and capabilities, and fostering constructive attitudes toward himself and society.

Technical subjects are viable educational vehicles that can serve effectively in the comprehensive development of youth for modern society. The focus of the technical disciplines is technology, which may be defined as the use, based on knowledge, of materials and the physical powers of nature for the purpose of serving human ends.

Some objectives of Elements of Mechanical Technology are:

- To encourage creative expression within the medium of science and technology
- To develop a positive attitude toward learning
- To reveal the close relation of the humanities, sciences, and the technologies
- To kindle a "childlike" curiosity which will find expression in a continuing thirst for knowledge about mechanical devices
- To make the student aware of a continually changing technological world
- To instill in the student a degree of confidence in his ability to comprehend complex industrial machines and processes
- To convey the fact that mature attitudes and good work habits enable the individual to achieve job satisfaction
- To provide an overview of Canadian industry, particularly with regard to mechanical technology
- To contribute to a sound educational base from which further education and training may proceed
- To prepare for employment by the development of basic technical skills

The teachers of Elements of Mechanical Technology are asked to keep these immediate objectives in mind at all times so that the student will be competent to:

- work amicably with others
- do individual research and work independently of supervision
- seek mathematical solutions to problems whenever possible
- plan his work schedule
- appreciate and practice good safety practices
- visualize and draw mechanical components
- relate assembly and detail drawings to production techniques
- prepare complete and accurate technical reports
- develop skill in discussion of technical topics
- use measuring and testing equipment competently
- diagnose mechanical failures
- perform basic machine operations

# COURSE ORGANIZATION

## DIVISION 1: CORE

**Unit** 1.1 Materials
**Section** 11.1 Metals
11.2 Non-Metals
11.3 Material Treatments

**Unit** 1.2 Manufacturing Methods and Processes
**Section** 12.1 Industrial Organization
12.2 Material Removal
12.3 Material Working
12.4 Casting and Moulding
12.5 Fabrication
12.6 Surface Coatings and Finishes
12.7 Inspection

**Unit** 1.3 Transmission of Power
**Section** 13.1 Shafts and Bearings
13.2 Lubrication
13.3 Drive Mechanisms
13.4 Fluid Power
13.5 Electrical Power

## DIVISION 2: DRAFTING AND DESIGN

**Unit** 2.1 Graphic Representation
**Section** 21.1 Basic Drawing
21.2 Advanced Projection Systems
21.3 Technical Charts and Graphs
21.4 Industrial Practices

**Unit** 2.2 Applied Mechanics
**Section** 22.1 Forces
22.2 Statics

**Unit** 2.3 Design Evaluation
**Section** 23.1 Design Considerations
23.2 Manufacturing Considerations
23.3 Quality Assurance
23.4 Creative Design Problems

## DIVISION 3: MACHINE THEORY AND PRACTICE

**Unit** 3.1 Machining Operations
**Section** 31.1 Lathe
31.2 Milling Machine
31.3 Drilling Machines
31.4 Sawing and Filing Machines
31.5 Grinding and Precision Finishing
31.6 Jig Boring
31.7 Shaping, Planing and Slotting
31.8 Special Processes

**Unit** 3.2 Bench Operations
**Section** 32.1 Layout
32.2 Fitting and Assembling

**Unit** 3.3 Metrology
**Section** 33.1 Measurement and Gauging
33.2 Testing

# DIVISION 1: CORE

## INTRODUCTION

This division identifies three units of the course common to both mechanical drafting and machine theory and practice: Materials, Manufacturing Methods and Processes, and Transmission of Power form a division that makes it mandatory for the two teachers concerned to develop the course of study together. It is quite possible that both teachers will present some information on all topics. The co-operation thus required for the construction of the course for Division 1 should be continued for Divisions 2 and 3.

Treatment of the Metals and Non-Metals Section should provide the student with an understanding of possible applications for these materials, based upon their chemical and physical characteristics. A study of manufacturing methods and processes will give a broad overview of Canadian industry and indicate employment trends and opportunities.

Unit 1.3, Transmission of Power, explores a wide spectrum of topics. The depth of treatment of any one topic must be decided by the teacher. It is expected, however, that gearing and cams will receive greater treatment than power screws or differential mechanisms. Since fluid power applications are becoming commonplace, the basic principles underlying this power source should receive special attention.

At first glance, the section headings might suggest a purely academic approach to methods of presentation. Upon further study, the teacher will realize that this division is ideally suited to the use of modern, imaginative techniques that may provide sixty to seventy per cent of classroom time for student activity. The discovery approach, classroom and home experiments, research projects, group discussions, field trips, and work experience programs may all be used to supplement formal lessons. Additional equipment and resource material will be necessary if a student-centred approach is to be maintained.

Liaison with other departments of the school, science in particular, will enhance the educational value of this division. Many topics will become more significant for the student if integration with other subjects can be achieved on a broad scale throughout the Grades 11 and 12 curriculum.

## UNIT 1.1 MATERIALS

**Metals**
- Ferrous
- Non-Ferrous

**Non-Metals**
- Plastics
- Elastomers (O)
- Miscellaneous (O)

**Material Treatments**
- Property Changes
- Thermal
- Mechanical

## UNIT 1.2 MANUFACTURING METHODS AND PROCESSES

**Industrial Organization**
- Types of Industries
- Company Structure
- Production and Marketing (O)
- Industrial Relations (O)
- Trends in Canadian Industry (O)

**Material Removal**
- Conventional Cutting Tools and Processes
- Special Processes (O)

**Material Working**
- Forging
- Extruding
- Stamping
- Bending and Forming
- Drawing
- Spinning

**Casting and Moulding**
- Gravity Casting (sand)
- Investment Casting
- Pressure Casting
- Moulding of Plastics
- Powdered Metallurgy

**Fabrication**
- Welding
- Riveting
- Threaded Fasteners
- Miscellaneous Fasteners (O)
- Adhesives (O)

**Surface Coatings and Finishes**
- Mechanical and Thermal Diffusion
- Electroplating
- Heat and Chemical Conversion

**Inspection**
- Definition and Purpose
- Tolerances
- Measuring Practice

## UNIT 1.3 TRANSMISSION OF POWER

**Shafts and Bearings**
- Principles
- Shafts
- Sliding Bearings
- Rolling Contact Bearings

**Lubrication**
- Fundamentals
- Fluid
- Grease and Solids
- Seals
- Systems (O)

**Drive Mechanisms**
- Gearing
- Cams
- Couplings
- Clutches
- Brakes
- Flexible Drives
- Miscellaneous Mechanisms (O)

**Fluid Power**
- Basic Principles
- Pneumatics
- Hydraulics
- Fluidics (O)

**Electrical Power (O)**
- Basic Principles
- Rotating Machines
- Transformers
- Control Systems

# DIVISION 2: DRAFTING AND DESIGN

## INTRODUCTION

The advantages of the integrated program become more apparent as the teacher presents the course of study. Topics such as working drawings, tolerances, threads, and gears are enhanced because the student must make calculations and use detail drawings in machining an object. The student who is employed in a drafting office will make a better contribution to any group effort if he understands various machining processes: these advantages can be given particular emphasis by the teacher of mechanical drafting.

The Section on Basic Drawing provides a brief review of the work covered in Grades 9 and 10 since timetabling arrangements can cause variation in the drafting abilities of Grade 11 students. Considerable time is allotted to the study of geometrical constructions, technical sketching, elementary projections, sectioning, dimensioning and tolerances, working drawings, and reproduction methods. A variety of student assignments designed to develop motor skills and spatial concepts will reinforce this section. The study of graphic reproduction methods such as microfilming, photographic processes, wet processes, and dry processes should be included.

The treatment of Industrial Applications is broad in scope. The teacher should emphasize the topics which relate to local industry. Field trips and work experience programs are ideally suited to reinforce the study of gears and cams, mechanisms, casting and forging design, and drafting office routines. Research assignments would permit the interested student to explore in depth, topics that have been given limited coverage because of time restrictions.

The tendency to present Statics as a series of lectures must be resisted. Individual students should undertake simple experiments on a basic material such as steel in order to understand the types of forces.

Design Evaluation introduces the fundamental problems and conditions which must be met before a manufactured product can be marketed successfully. Opportunities for the teacher to break away from traditional methods of lesson presentation are enhanced by the nature of the content of this unit. Individual student study should be encouraged. Visits to local industries as well as consultation with produce engineers and other industrial personnel will enrich this part of the course.

Although no topics have been listed under Creative Design Problems, this section is included because students should be given the opportunity to attempt creative solutions to realistic technological problems. The situations requiring resolution may range over the entire course and beyond: they may relate to the locality or to a student's particular interest. They may demand many skills: mathematical, graphical, aesthetic, and manipulative. Since the possibilities are endless, no specific problems have been suggested.

## UNIT 2.1 GRAPHIC REPRESENTATION

**Basic Drawing**
- Geometrical Construction
- Technical Sketching
- Elementary Projections
- Sectioning
- Dimensioning and Tolerances
- Working Drawings
- Reproduction of Drawings

**Advanced Projection Systems**
- Auxiliary Views
- Revolutions
- Axonometric Projection (O)
- Oblique Projection
- Perspective Projection (O)
- Intersections and Developments

**Technical Charts and Graphs**
- Types of Charts and Graphs
- Engineering Graphics

**Industrial Practices**
- Drafting Office Routine
- Structural
- Electrical and Electronic (O)
- Casting and Forging
- Threads, Fasteners, and Springs
- Gears and Cams
- Mechanisms
- Tool Drawings
- Welding
- Piping (O)
- Fluid Power
- Technological Innovations:
  - Display, Plotter and Reduction Systems (O)

## UNIT 2.2 APPLIED MECHANICS

**Forces**
- Description
- Types
- Vector Analysis
- Turning Effects
- Equilibrium of Forces

**Statics**
- Tensile
- Compressive
- Shear
- Bending Moments
- Twisting Moments (O)
- Failure under Load

## UNIT 2.3 DESIGN EVALUATION

**Design Considerations**
- Aesthetic Features
- Functional Features

**Manufacturing Considerations**
- Available Methods and Processes
- Selection of Materials
- Costs

**Quality Assurance**
- Relationship to Design
- Quality Control

**Creative Design Problems**

# DIVISION 3: MACHINE THEORY AND PRACTICE

## INTRODUCTION

Although sophisticated machine tools are available, industry is unable to realize their potential because of a lack of trained personnel. One objective of this division is to provide graduates who will fill this gap. Many of the latest machining processes have been included under special processes. The treatment of hydraulic tracers, mechanical tracers, electro-discharge machining (E.D.M.) and others is not intended to be exhaustive. The students should see these operations during a field trip or under some other special arrangement; they should then be encouraged to undertake independent study and research within this unit.

Integration of content between Divisions 2 and 3 will require considerable skill by participating teachers. Machining exercises rather than projects will facilitate the transition of ideas and concepts from drafting board to finished product; for example, the study of threads in the drafting room will become more significant to the student if he is required to produce two or three short test threads in the machine shop.

Several advantages of successful integration between Divisions 2 and 3 have already been mentioned in the Foreword. Three others should be mentioned:

- The student who ultimately wishes to enter a tool room or machine shop will find that his ability to interpret drawings, to foresee possible design weaknesses, and to pick out actual mistakes on drawings and blueprints is sharpened by the dual purpose concept of this course.
- The student desirous of entering a machine design or a mechanical design drafting office will find that his improved background knowledge in basic machine tool operations and material treatment will contribute much to his success as a draftsman.
- Teachers who take the time to plan for student activity whereby knowledge and skills gained in the drafting room or machine shop are applied to the other subject area increase their own understanding of their subject field, and may encourage other staff members to explore the possibilities of integrating other subjects of the curriculum.

## UNIT 3.1 MACHINING OPERATIONS

**Lathe**
  Turning
  Hole Production
  Threading
  Work Holding Devices
  Cutting Tools and Tool Holding Devices

**Milling Machine**
  Standard Milling Operations
  Form Milling Operations
  Indexing Operations
  Attachments and Work Holding Devices

**Drilling Machines**
  Operations
  Hole Finishing

**Sawing and Filing Machines**
  Sawblade Selection
  Sawing
  Filing

**Grinding and Precision Finishing**
  Work Holding Devices
  Grinding Wheels
  Standard Grinding Operations
  Super Finishing (O)

**Jig Boring**
  Introduction
  Operation
  Applications

**Shaping, Planing, and Slotting**
  Operations
  Work Holding Devices

**Special Processes**
  Tracers
  Turret Lathe
  Screw Machines (O)
  Boring Mills (O)
  Numerical Control
  Electro-Discharge Machining (E.D.M.)
  Electro-Chemical Machining (E.C.M.)
  Ultra-Sonic Machining (U.S.M.) (O)

## UNIT 3.2 BENCH OPERATIONS

**Layout**
- Surface Preparation
- Tools and Equipment

**Fitting and Assembling**
- Cutting Tools
- Assembly Devices and Methods

## UNIT 3.3 METROLOGY

**Measurement and Gauging**
- Science of Measurement
- Measuring Instruments
- Gauging Equipment

**Testing**
- Non-Destructive
- Destructive

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